Two types of Bragg blazing in leaky wave structure – Lorentzian and Fano profiles

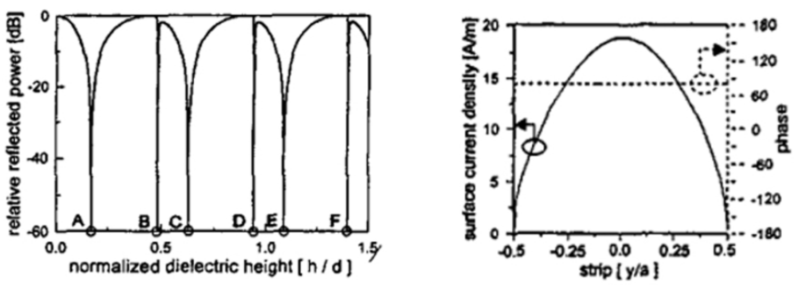
Soonwoo Park(1), Hongjoon Kim(1), Young-Ki Cho(1), Ji-Hwan Ko(2), Sangwook Nam*(3)
(1) Kyungpook National University, Daegu, Rebulic of Korea, e-mail: soonwoo@knu.ac.kr; hongjoon@knu.ac.kr; ykcho@ee.knu.ac.kr
(2) Kumoh National Institute of Technology, Gumi, Republic of Korea; e-mail: kojh@kumoh.ac.kr
(3) Seoul National University, Seoul, Republic of Korea; e-mail: snam@snu.ac.kr

We deal with Bragg blazing, i.e., retroreflection phenomena occurring in the periodic array of the conducting strip over the grounded dielectric, which is chosen as a leaky wave structure [1]. To this end, we investigate the theoretical results for the variation of the specularly reflected power versus normalized dielectric thickness (h/λ) for the incidence angle $\theta_i = \sin^{-1}(\lambda/2d) = 25°$ for the case that period $d = 1.181\lambda$, conducting strip width $a = 0.5d$, relative dielectric constant $\varepsilon_r = 1.03$, where λ means a free space wavelength. Some numerical example for TM polarization case where incident magnetic field is parallel to the strip axis is given in Fig. 1 (a). Six cases of Bragg blazing phenomena corresponding to the points A-F are observed. From the Figure it is seen that the six cases of Bragg blazing phenomena can be divided into two kinds, one is an (inverted) Lorentzian profile type which is almost symmetrical with respect to the dip like, A, C, and E cases and the other is a Fano profile type which is unsymmetrical and goes through an abrupt dip to zero locus like B, D, and F cases.

In order to understand the difference of the Bragg blazing between the Lorentzian and Fano profiles further, we have investigated the induced current distribution over the conducting strip for the two cases. As a representative example among B, D, and F cases for which all the current distributions are essentially the same to one another, the current distribution corresponding to the case B is illustrated in Fig. 1 (b). This current distribution qualifies as a characteristic mode current [1] of the structure since the current distribution has precisely constant phase across the strip although the magnitude of the current significantly varies across the strip, quite different from that for A, C, and E cases.

For the purpose of examining the relationship between the Bragg blazing phenomena and leaky waves, we look into the dispersion diagram. The Bragg blazings corresponding to B, D, and F cases are observed to occur only when $\beta_{m0}d = \pi$ (and also 2π for the three propagating mode problem [1]) and at the same time $\alpha_0 d$ is observed to become minimum (called as the coupling point condition). On the other hand, the Bragg blazing phenomena corresponding to A, C, and E cases occur irrespective of the above coupling point condition.

Here β_{m0} means the propagation constant of the m-th order number of the leaky wave root, α_0 the attenuation constant, and the subscript 0 means the zeroth order among the Floquet mode. Note also that for the B, D, and F cases, dielectric thickness is roughly integer multiple the half wavelength. The Fano profile type of Wood anomalies are observed to occur under these conditions.



(a) (b)

Figure 1. (a) Six Bragg blazing phenomena (A-F) and (b) Induced current distribution.

References

[1] C. H. Lee, U. H. Cho, and Y. K. Cho, "Revisited generalized Wood anomalies", IEEE AP-S International Symp. Proc. pp. 1754-1757, Florida, Orlando, USA, 1999.